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CULTURE OF MARINE FISHES IN THE THIRD WORLD

by

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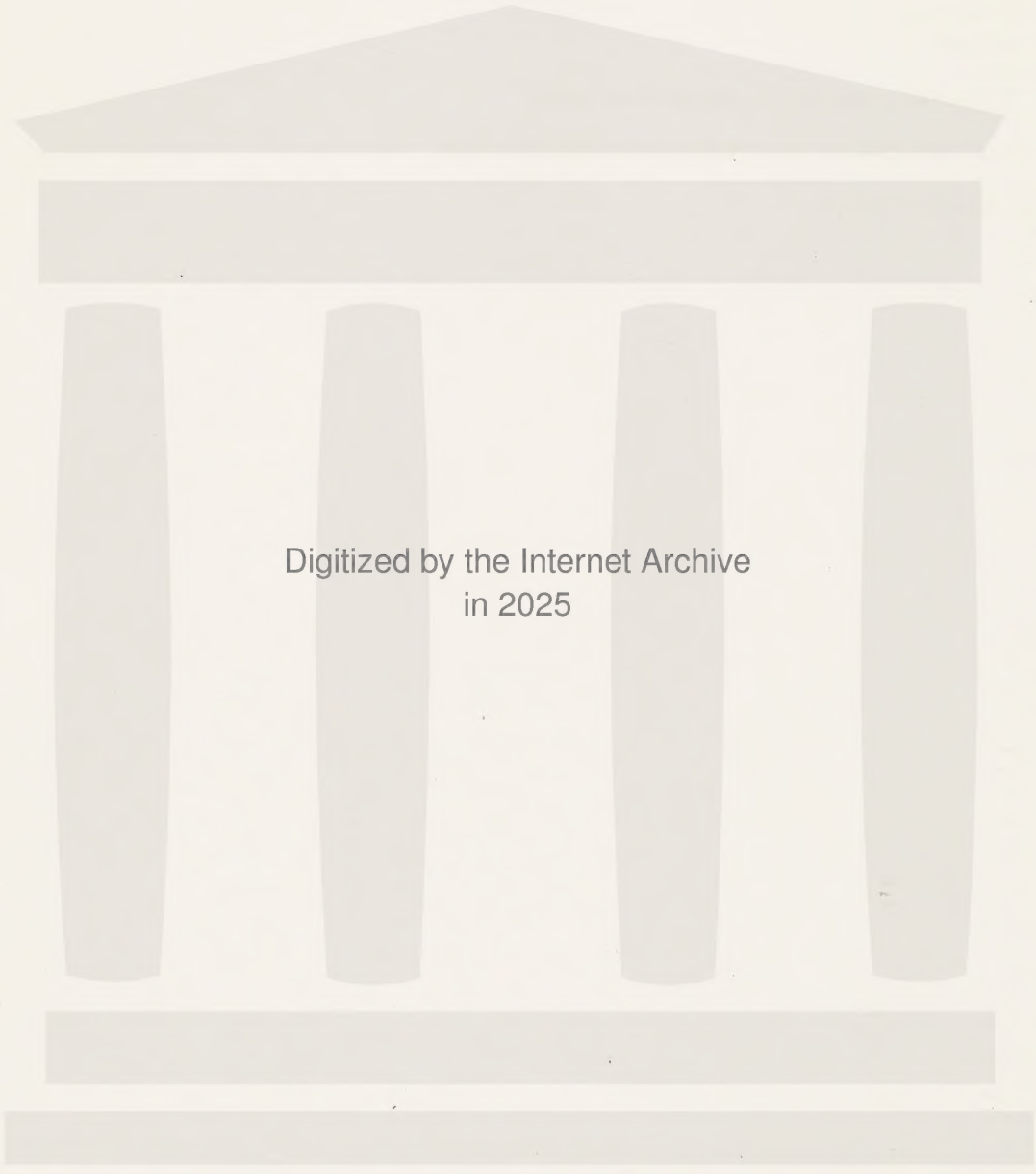

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1. INTRODUCTION

During the FAO Technical Conference on Aquaculture, held in Kyoto, Japan, 26 May to 2 June 1976, it was announced that, based on available information, world production through aquaculture had been estimated to have passed the 6 000 000 ton mark. Taking into consideration that world fishery production from all sources in 1975 amounted to about 70 000 000 tons, the share of aquaculture production is not insignificant (8.5 percent). It is quite likely that world aquaculture production is higher than that referred to above because of the difficulties in obtaining reliable production data, particularly from developing countries where the statistical services are poorly manned and organized.

An analysis of the world aquaculture production in 1975, by kind, and in round figures can be given as follows:

	Production (tons)	Percentage
Finfish	3 980 000	66.0
Crustaceans (shrimps and prawns)	16 000	0.3
Molluscs (oysters, mussels, clams, scallops, cockles, etc.)	978 000	16.2
Seaweeds	1 055 000	17.5
	6 029 000	100.0

It may be of interest to point out that more than 80 percent of the world aquaculture production in 1975 was produced in the Indo-Pacific Region, with the highest production by country reported as the People's Republic of China, which had an estimated production of 2.2 million tons. This is about 37 percent of the total aquaculture output and 55 percent of world finfish culture production.

While the above summarized information demonstrates the importance of the Indo-Pacific Region as a major producer of aquaculture products, in the absence of breakdown data, except for crustaceans, molluscs and seaweeds, some difficulties are experienced in arriving at reliable production figures of cultured finfish species from various aquatic regimes, particularly in developing countries. On the basis of published and unpublished sources, it can be safely stated, however, that between 90 and 95 percent of the finfish production in developing countries is derived from the culture or husbandry of freshwater species, principally based on common carp, Chinese carps, Indian major carps, tilapias, air-breathing species (i.e., Anabas, Ophicephalus, Clarias, Heteropneustes, etc.) and salmonids.

The culture of entirely marine or stenohaline species is still insignificant on a global basis. The culture of brackishwater and inshore marine fishes, like the milkfish (Chanos chanos), which has been farmed in Indonesia since the early fifteenth century, of several mugilids (Mugil spp.), and recently, the grouper, Epinephelus tauvina (Serranidae), the sea bass, Lates calcarifer (Latidae), the red porgy, Chrysophrys major, and black porgy, Mylio macrocephalus (both belonging to the family Sparidae), is on the other hand of considerable economic importance to several countries in the Indo-Pacific Region, a subject deserving some attention.

2. CULTURE OF BRACKISHWATER AND INSHORE MARINE FISHES

2.1 Milkfish

Chanos chanos is widely distributed in the tropical and sub-tropical areas of the Indian and Pacific Oceans, from the Red Sea to Australia, and from southern Japan to San Francisco Bay and southern Mexico. Being an euryhaline species, disease resistant, a herbivore (feeding mostly on algae), and exhibiting good growth rates, it is considered as one of the fishes best suited for culture in brackishwater ponds.

It spawns, annually or bi-annually, offshore in depths between 20 and 25 m, and larvae seek clear coastal waters. When about one year old and about 20 cm long and 200 g in weight, they move out to sea to mature. They live up to six years and adults may reach weights of up to 20 kg. The fecundity is high: up to seven million eggs have been estimated to be produced by a single large female.

Milkfish are presently cultivated on a large scale only in Indonesia, the Philippines and Taiwan, Province of China, but also on a small scale or experimental basis in Thailand, Malaysia, Democratic Kampuchea (ex Khmer) and Vietnam.

According to available information, the annual production and area under milkfish culture in the first three principal countries is as follows:

Country	Area (ha)	Production (tons)	Year
Indonesia	184 000	55 000	1973
Philippines	176 000	113 000	1974
Taiwan	16 000	29 000	1974

It can be easily observed that the yields per cultivated area are quite variable, almost 1 800 kg/ha in Taiwan, Province of China, as against 300 kg/ha in Indonesia and 642 kg/ha in the Philippines. These, of course, are national averages, and yields within the country vary considerably, particularly where improved culture methods have been introduced.

It will not be out of context to briefly mention the methods of culture or farming of milkfish. As milkfish spawn offshore the fry are gathered by different types of collectors ("blabar" in Indonesia, dipnets in the Philippines, triangular scoopnets in Taiwan, Province of China), when they approach the sloping sandy beaches with clear water and the mouths of tidal creeks and streams. Captured fry are immediately transferred to earthen jars (Indonesia and Philippines), or to wooden buckets and small cement troughs on the beach (Taiwan, Province of China). Acclimatization to brackish water may commence immediately or at a later stage. Collected fry pass through several middlemen before they reach the actual farmer. On arrival at the farm they are released into the specially prepared nursery ponds, and stocked at the rate of 30 to 50/m^2. The size of the nursery ponds varies from 200 to 5 000 m^2, and the depth does not exceed 30 cm. Feeding or care of the fry is not uniform in the countries mentioned. In Indonesia the natural algal blooms plus some supplementary feeding (rice bran given once or twice daily) are considered adequate, while in the Philippines and Taiwan, Province of China, fertilization is applied (in Taiwan dried chicken droppings or hog manure at the rate of 500 to 1 000 kg/ha) to promote the growth of benthic algae. Growth is rapid, about 1 mm/day and by the end of one month the fry attain lengths of 5 to 7 cm and weights of 1.4 to 3.7 g. They can then be transferred to the rearing or growing ponds which should be so situated that salinity averages 10 to 35°/oo. In Indonesia the size of the ponds, known as "tambaks", ranges from 0.5 to 3.0 ha, but in east Java the average size is 7 ha, and some may reach 30 ha. In the Philippines the production ponds range from 1 to 50 ha, and in Taiwan, Province of China, from 3 to 6 ha.

Milkfish are normally harvested at 300 to 800 g. They are being sold fresh or iced, but also cured in brine or smoked.

In Indonesia the annual production of milkfish per ha varies from place to place but, when compared to other neighbouring countries, is relatively low. Yields range from 280 kg/ha in west and central Java to 320 kg/ha in east Java. It has been demonstrated lately that through improved practices, particularly through credit schemes, production could be increased to 600 kg/ha/yr in west and central Java and to 800 kg/ha/yr in east Java and south Sulavesi. In addition, the amplification of the composite culture or polyculture of milkfish and penaeid shrimps has increased considerably the net income of the farmer, due to the fact that shrimp prices range from U.S.$ 2.40 to U.S.$ 4.80/kg, according to size, against the average price of U.S.$ 1.20 for milkfish. Of course, shrimp yields are low in comparison to milkfish, ranging between 50 and 150 kg/ha/yr.

In the Philippines the average yield from traditional practices has been estimated at from 300 to 500 kg/ha. Since 1966, through the advice of FAO biologists, improved techniques, as used in Taiwan, Province of China (i.e., scientific use of fertilizers, supplementary feeding, pest control, harvesting of smaller fish and continuous planting and cropping) have been adopted. Where these techniques are practised, the average yields increased to 1 000 kg/ha. More dramatic changes took place early this decade, when milkfish was introduced into the Laguna de Bay, near Manila, and reared in an experimental 38-ha bamboo barricade. The first harvest, after five months of rearing in naturally-growing phytoplankton in the lake, showed an average yield of 700 kg/ha. Within two years of the initial experiment fish pens covered an area of 4 800 ha producing 19 200 tons of milkfish, or 4 000 kg/ha as compared with 413 kg/ha from the remaining cultivated area. In 1975, 20 000 to 25 000 tons of fish, primarily of milkfish, were produced from fish pens covering an area of 7 000 ha. Yields of up to 10 tons/ha have been reported. The fish-pen industry of Laguna de Bay has an investment of about U.S.$ 13.5 million.

Milkfish are presently cultured at the experimental fish farm at Ambo, Tarawa, Gilbert Islands, not only for human consumption but also to be used as live bait for skipjack tuna. Production rates of up to 1 000 kg/ha/yr have been obtained in initial experiments by the UNDP/FAO project without fertilization or artificial feeding. The promotion of milkfish culture in Fiji was also supported by another FAO project.

Any future increases in milkfish production, apart from the application of improved aquaculture methods, are directly dependent on the availability of fry for stocking purposes. Shortages of seed as a result of wide natural fluctuations (128 million fry in 1972 as compared to 207 million in 1970 in Taiwan, Province of China), or more recently from pollution, are not uncommon in the major producing countries. All attempts at breeding the milkfish in captivity, until quite recently, have been unsuccessful. Early this year, however, the Southeast Asian Fisheries Development Centre (SEAFDEC) based at Iloilo, Philippines, announced the successful induced spawning through the administration of salmon pituitaries and human chorionic gonadotropin. This news is very encouraging, but we shall have to wait until techniques are developed for fry production on a large scale.

Another serious problem in many localities is the sustaining of the salinity of pond water within the favourable range, especially where there is no reliable supply of fresh water to compensate for the high rate of evaporation, and where there is no efficient drainage system to divert rain water from the pond system during the rainy season.

2.2 Mullet

Another species or several species which play an important role in fish culture, notably in the Mediterranean and southeast Asia, and have a great potential in South America, are the mullets. They exhibit wide salinity and temperature tolerance. They feed on plankton, benthic algae and decaying organic matter, and easily accept rice bran and groundnut meal as supplementary feeds.

Mullets are presently cultured or farmed, particularly in polyculture, in Italy, Greece, Israel, Egypt, Iraq, India, West Bengal, Bangladesh, China, Hong Kong, Taiwan, Province of China, and, on a smaller scale or experimental basis, in Yugoslavia, Cyprus, Tunisia, Mauritius, Indonesia, Malaysia, Philippines, Thailand and El Salvador. The possibilities of mullet culture in other regions or areas have also been investigated by FAO, and culture trials were conducted by FAO biologists in Fiji, Gilbert Islands (Indo-Pacific Region), Cuba and Colombia. Very encouraging results were obtained from the last two countries.

Mullet production figures through aquaculture practices are scanty, except for isolated cases. For example, mullet production in Israel derived from fish ponds and Lake Kinneret in 1975 was respectively 480 and 140 tons, while in Taiwan, Province of China, it amounted to 1 300 tons in 1974. Similar difficulties are faced in obtaining production yields from farming practices. In Israel yields of up to 500 kg/ha from a composite culture with tilapia have been obtained during a four-month growing period. In Egypt, in the North Delta Lakes,

yields are relatively low, from 20 to 60 kg/ha. The highest yields, however, have been reported from Hong Kong, up to 2 500 kg/ha in a 300-day growing season.

It will be of interest to refer to the culture trials conducted by the FAO project in Cuba with three local mugilid species (Mugil liza, M. curema and M. trichodon) in four ponds covering a total area of 0.35 ha at Tarará, east of Havana. The best yield obtained was 1 000 kg/ha/yr in a semi-intensive culture of M. liza with rice bran as supplementary feeding as against 230-300 kg/ha/yr reared under natural conditions.

In Colombia, the FAO Inland Water Fishery Development Project commenced, in 1974, a stocking programme with lebranche (Mugil brasiliensis) and lisa (M. insilis) in freshwater lagoons and cattle-drinking ponds. The fry of both these species approach the Caribbean coast of Colombia in millions annually during February and March. The best results so far obtained have been those from the stocking trial with lebranche fingerlings in 1975 and with lisa in February 1976 of a 25-ha cattle drinking pond near Cartagena. Without supplementary feeding, lebranche fingerlings of 6 cm in length and 1.8 g in weight, after an eight-month period, attained average length of 40 cm and 800 g in weight. By the end of November 1976, the average size was 60 cm and 1.5 kg in weight. With regard to lisa, after an eight-month period, individuals measured between 30 and 40 cm and weighed 300 to 500 g.

Although M. cephalus, the striped mullet, the most widely distributed and also commercially important species, has been artificially spawned through the administration of pituitary extracts and synthetic hormones as early as 1964, the production of fingerlings is still extremely low after a decade or more, and has not exceeded the 25 000 mark in the principal hatchery facilities in Taiwan, Province of China, and Hawaii. Similar difficulties still persist with other mugilid species, i.e., M. capito, M. macrolepis and M. troschelli, which have all spawned with the aid of pituitary injections.

Until the dietary requirements at a very early larval stage are resolved, the cultivation of mullet will entirely depend on the supply of fry from the wild. At present, no marked reduction in fry availability has been observed, but some declining catches of fry have been reported from Israel. Quite possibly as industrial and domestic pollution takes an upward trend, particularly in enclosed seas like the Mediterranean, the availability of mullet fry will be gradually affected.

2.3 Eels

To my knowledge, there is only one developing country which, having introduced eel culture about 25 years ago, has been successful, not solely to attain sufficient production for the home market, but also to export to foreign markets. The success, of course, was gradual. In 1966 there were only about 60 ha of eel ponds in Taiwan, Province of China, but by mid-1973 the total acreage reached 1 200 ha. In 1974, eel production, through farming, was reported as 11 830 tons, of which 6 800 tons or 57 percent was exported, earning U.S.$ 42 million in foreign exchange.

Two species support the eel culture activity, the Japanese eel (Anguilla japonica) and the imported European eel (A. anguilla). Another local species, A. marmorata, which is found in abundance along the east coast of the country has not exhibited desirable qualities for rearing purposes in ponds.

The culture of eels involves considerable attention and acquired knowledge in the management of the nursery and rearing ponds. Eels require well oxygenated water, free from pollutants, especially pesticides, and temperatures of about 12°C (below 12°C feeding and growth cease). The susceptibility of cultured eels to diseases raises serious problems in their culture.

In view of the rapidly increasing demand and high prices obtained in domestic and foreign markets, eel farming operations on an experimental basis have commenced in several countries in southeast Asia, e.g., Thailand, Malaysia, Indonesia, Vietnam and the Philippines. Varied degrees of success have been reported.

The possibility of eel culture in Cuba has not been overlooked by the National Directorate of Aquaculture, and the first eel culture station to investigate these potentialities, was established early in 1975 at Cotorro, about 30 km southeast of Havana. The total area of the nursery, rearing and experimental ponds, will cover about 10 ha. In February 1975 about 5 million elvers of one to three months old were kept in Cotorro. The species occurring along the coasts of Cuba is A. rostrata.

2.4 Groupers, snappers, seabreams, etc.

A new venture in some countries in southeast Asia is the farming of high-priced species in pens or floating cages. The existing operations are still in the early stage of development, but the future is quite promising assuming the seed supply can accommodate the increasing demand.

During my visit to southeast Asia a few years ago, I observed at several sites the rearing of groupers (Epinephelus tauvina) in Malaysia and Singapore, snappers (Lutjanus sp.), seabreams (Chrysophrys spp.) in Hong Kong, and seabass (L. calcarifer) in Thailand. The net cages are set on rafts or floats in areas well protected from storm and strong wave action and where the water has a constant moderate flow. The seed or fingerlings are either collected by the farmers themselves or, more normally, purchased from coastal fishermen. About three years ago the purchasing price of Epinephelus near Penang, Malaysia, was between U.S.$ 0.13 and U.S.$ 0.21, and the selling price, after about 10 to 12 months rearing, about U.S.$ 2.00. Such an installation operated by a family at Jelutung, Penang, can handle about 20 000 fish/year. Fish are fed daily with trash fish obtained from the fishing fleet.

According to recent information, the purchasing price of individual fry in the Straits of Johore, southern Malaysia, is about U.S.$ 0.50 and the selling price, after one year of rearing, about U.S.$ 3.00 to 3.50. The Fisheries Department has agreed to promote the development of cage culture, and a subsidy of about U.S.$ 900 will be provided to each fisherman for the construction of four cages, purchase of seed and fish food.

About four years ago the Government of Singapore, through the Department of Primary Production, initiated experiments for growing E. tauvina in net cages. Six cages of 5 x 5 m have been placed in an enclosure protected by netting and supported by bamboo poles, at Changi Point. Fish were kept at different densities to observe growth rates, but fed once daily with chopped fish. The Department is placing priority in research programmes on induced breeding of the culture species such as grouper, seabass and ornamental fish. Initial success in the induced spawning of E. tauvina has been reported early this year.

A programme for the culture of seabass (L. calcarifer), has been conducted at the Marine Fisheries Station at Songkhla, south Thailand, since 1972. Fry are collected from the wild and, when measuring about 2 to 5 cm, are transferred to small nylon cages immersed in nursery ponds. After three months, when they attain lengths of 20 cm and weights of 200 to 250 g, they are transferred to the larger enclosures having a mesh of 2 to 4 cm. The net enclosures are of various dimensions (10 x 10 x 3 m; 5 x 10 x 2 m; 2 x 3 x 2 m) and reared under different stocking densities (from 2 to 10/m^2). Feeding consists of trash fish (conversion 10:1), or on an experimental basis on pellets (fish meal, rice bran and vitamins).

Parallel to the rearing experiments, the research workers at Songkhla investigated the possibility of the induced spawning of this fish and the first success was achieved in August 1973, by the administration of human chorionic gonadotropin.

The culture of marine inshore fishes in floating cages commenced in Hong Kong in 1970. From a survey made in 1973 it was shown that there were 460 units, consisting of 2 076 cages with an estimated 260 tons of fish under culture. The species used are groupers, seabream (Chrysophrys major), porgies (Mylio spp.), mangrove snapper (Lutjanus sp.) and siganids (Siganus spp.). The cages are made of synthetic netting, wooden slats or bamboo and supported by floats or rafts. A group of cages is normally placed into a large net enclosure. The dimensions vary from 2.5 x 2 x 2 m to 4 x 3 x 3 m, but some of larger size, 13 x 6 x 3 m, also exist. Seed is purchased from other fishermen and are sold when they attain weights of about 400 to 450 g. They are fed on trash fish. According to an unpublished report, the annual harvest is presently in the order of 700 tons.

3. NEW DEVELOPMENTS IN THE REARING OF MARINE FISH

The importance of controlled reproduction of fishes in the development of aquaculture has been recognized for several decades, and this has also been emphasized during numerous scientific gatherings, symposia and conferences convened by FAO and other leading research institutions and agencies.

Time does not allow a review of the successes, failures and outstanding problems to be solved in relation to the induced breeding and culture of several marine finfish species of economic importance. Nevertheless, as a result of the technological advances made during the last few decades in controlled breeding and larval rearing, it has been possible to accelerate considerably the pace in arriving at the stage where the culture of marine fish is feasible on a commercial scale.

A recent development, which is of considerable importance for the Mediterranean area, is the culture of the seabass (Dicentrarchus labrax) on a commercial scale in Italy, as a follow-up of the knowledge obtained from the research work conducted since early in 1970, initially in France and, at a later stage, in Italy. The projected production is 100 tons annually (market price in Italy varies from U.S.$ 10 to U.S.$ 15 and in France from U.S.$ 7 to U.S.$ 10). Research work in the rearing of both seabass and gilthead bream (Sparus auratus), another highly esteemed and priced fish in countries surrounding the Mediterranean Sea, is conducted in Israel. Technical assistance to this programme has been provided by FAO.

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